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(54) Title: CELLULAR TELEPHONE WITH REDUCED RADIATION EXPOSURE		
(57) Abstract		
<p>A cellular phone (10) is provided for reducing a user's exposure to RF radiation emitted by cellular phone antennas (20). The phone (10) includes a base unit (12) and a detachably connected handset (14). The base unit (12) includes an antenna (20) for establishing an RF communication link to a wireless communications network. It also includes circuitry for converting RF signals to electrical signals, and electrical signals to RF signals. The handset (14) includes an earpiece (28) and a mouthpiece (30) for receiving and transmitting audio signals to and from a user. It also includes circuitry for converting the input audio signals into electrical signals and electrical signals into output audio signals. The phone is operable in two modes: a standard use mode and a reduced RF radiation exposure mode. In the standard use mode, the base unit (12) and the handset unit (14) are attached and operated as a single unit. Contacts on the base unit (12) engage corresponding contacts on the handset (14) to enable direct electrical transfer of signals between the base unit and the handset. To use the phone in the reduced exposure mode, the handset is detached from the base unit. The base unit is placed a distance of about three feet from the user, and communication between the base unit and the handset is established through an infrared optical communications link.</p>		

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## CELLULAR TELEPHONE WITH REDUCED RADIATION EXPOSURE MODE TECHNICAL FIELD

The present invention relates generally to cellular phones and, more particularly, to cellular phones designed to reduce a user's exposure to electromagnetic radio frequency ("RF") radiation emissions from cellular phone antennas.

### BACKGROUND OF THE INVENTION

Personal communication devices such as cellular telephones and hand-held radios have proliferated in recent years, and the next generation of these devices is expected to be even more prevalent. While the devices provide users with a convenient means of communication, they raise serious safety concerns, particularly with the users' constant exposure to electromagnetic RF emissions from cellular phone antennas. RF antenna emissions have been reported to be linked to increased risk for head anomalies such as brain cancer.

Several designs have been proposed to reduce electromagnetic exposure from cellular phones. Many of these involve using some type of electromagnetic shield such as those disclosed in U.S. Pat. No. 5,335,366 issued to Daniels, U.S. Pat. No. 5,338,896 issued to Danforth and U.S. Pat. No. 5,336,896 issued to Katz. The Katz patent, for example, discloses an electromagnetic shielded jacket for encasing a cellular phone. Round openings are provided in the jacket adjacent to the earpiece and the mouthpiece to allow sound waves to freely pass. Doors are provided for allowing limited access to the keypad. After a telephone number has been dialed or some other control button depressed, the user can close the door to reduce exposure to radiation emanating from the keypad. Unfortunately, these jackets are cumbersome. They are also not generally compatible with popular flip-phones, in which the mouthpiece is located on a hinged door, which flips to a closed position when not in use to cover the keypad.

Furthermore, while the Katz jacket purportedly shields a user from RF emissions radiating from the phone keypad, a significantly greater health threat has been associated with the much higher emissions radiating from the phone antenna. Katz addresses the antenna issue by 5 installing atop the jacket a telescoping antenna that is hinged at the bottom so that it can be tilted away from the user's head. While this may reduce exposure somewhat to emissions from the tip of the antenna, the base of the antenna remains the same distance from the head. Telescoping antennas are known to emit radiation along their entire length 10 from tip to base. Moreover, when the tip of the Katz antenna is swiveled away from the head, it is inadvertently moved closer to the user's arm, shoulder, back or chest. Thus, the swiveling antenna design accomplishes little more than partially displacing the health risk from one part of the body to another.

15 Other designs for reducing electromagnetic emissions to the user's head involve modifying the design of the antenna itself. For example, U.S. Pat. No. 5,231,407 issued to McGirr et al. discloses an antenna comprising radiating patch elements enclosed in a portable telephone chassis. The near field of the antenna is configured to reduce radiation 20 exposure to the user's head. Again, while the alternate antenna design might reduce exposure to the head, it inadvertently increases exposure to the user's hand or shoulder. Furthermore, transmission and reception is hindered since a larger part of the user's body absorbs antenna radiation.

In another design (disclosed in U.S. Pat. No. 5,528,689 issued to 25 Alex Y. Chan), a headset is connected to a cellular phone using rubber tubes similar to those used in earlier generation airplane headphones. Apart from sound quality problems, the Chan device is cumbersome. It also reduces cellular phone portability since the user must carry two long rubber tubes and a separate headset when carrying the phone.

Therefore, a need exists for a cellular phone that effectively reduces harmful radiation exposure to the user and that is portable, easy to use, and provides good sound quality.

#### BRIEF SUMMARY OF THE INVENTION

5 One object of the present invention is to provide a cellular telephone that significantly reduces harmful radiation exposure to all portions of the user's body.

Another object of the invention is to provide a cellular phone that reduces radiation exposure and is portable and wireless.

10 A further object of the invention is to provide a cellular phone that reduces radiation exposure and that is easy to use and provides good sound quality.

These and other objects of the invention are achieved by a cellular phone operable in two modes: a standard use mode and a reduced 15 exposure mode. The phone includes a base unit and a detachably connected handset. The base unit includes an antenna for establishing an RF communications link to a wireless communications network. It also includes circuitry for converting RF signals to electrical signals, and electrical signals to RF signals. The handset includes an earpiece and a 20 mouthpiece for receiving and transmitting audio signals to and from a user. It also includes circuitry for converting the input audio signals into electrical signals and electrical signals into output audio signals.

In the standard use mode, the base unit and the handset are attached and used as a single unit. Contacts on the base unit engage 25 corresponding contacts on the handset to enable direct electrical transfer of signals between the base unit and the handset.

To use the phone in the reduced exposure mode, the handset is detached from the base unit. The base unit is placed a distance of about three feet from the user, and communication between the base unit and 30 the handset is established through an infrared ("IR") optical communications link.

In this manner, harmful RF radiation exposure is significantly reduced to all portions of the user's body. In addition, the phone is portable and wireless. It is also easy to use and provides good sound quality.

5       The foregoing has outlined some of the more pertinent objects of the present invention. These objects should be construed to be merely illustrative of some of the more prominent features and applications of the invention. Many other beneficial results can be attained by applying the disclosed invention in a different manner or modifying the invention as will  
10      be described. Accordingly, other objects and a fuller understanding of the invention may be had by referring to the following Detailed Description of the preferred embodiment.

#### BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention and the  
15      advantages thereof, reference should be made to the following Detailed Description taken in connection with the accompanying drawings in which:

FIGURE 1 is front view of a cellular phone in accordance with the invention in a folded, non-use position;

20      FIGURE 2 is side view of the cellular phone also in the non-use position;

FIGURE 3 is a front view of the cellular phone in a standard use mode;

FIGURE 4 is a side view of the phone also in a standard use mode;

25      FIGURE 5 is a view of a user using the phone in a reduced exposure mode;

FIGURE 6 is a schematic block diagram illustrating the digital portion of a cellular phone in accordance with the prior art; and

30      FIGURE 7 is a schematic block diagram illustrating the IR communication link of the phone in accordance with the invention operating in a reduced exposure mode.

## DETAILED DESCRIPTION

FIGURES 1 and 2 illustrate a cellular phone 10 in accordance with the present invention in a folded, non-use position. The phone 10 comprises two detachably connected parts: a base unit 12 and a user interface unit in the form of a handset 14. (The handset 14 is shown folded in FIGURES 1 and 2.)

The base unit 12 includes a standard LCD display 16 and a control keypad 18. A telescopic antenna 20 extends from the base unit 12 for cellular RF transmission to a wireless communication network (not shown). The antenna 20 is the source of the radiation for which reduced exposure is desired. The term RF transmission as used in this specification is intended to encompass all transmission frequencies used presently and hereinafter in wireless cellular communication.

The handset 14 comprises two members 22, 24 connected by a hinge 26 such that they can be compactly folded. The member 22 contains an earpiece 28, and the member 24 contains a mouthpiece 30. A microphone 32 is positioned at the mouthpiece 30, and a speaker 34 at the earpiece 28.

The phone 10 includes a first IR send/receive unit or element 36 located on the base unit 12 and a corresponding second IR send/receive unit or element 38 located on the handset 14 for establishing an IR optical communications link, which will be described in further detail below.

The cellular phone 10 can be operated in one of two modes: a standard mode as illustrated in FIGURE 3 and 4, and a reduced emission mode as shown in FIGURE 5.

The phone 10 is used in the standard mode if the user has no time or sufficient space to use the phone in the reduced exposure mode. To use the phone 10 in the standard mode, the user simply pivots the mouthpiece member 24 of the handset 14 about the hinge 26 into the unfolded position shown in FIGURES 3 and 4. Contacts 40 on the

handset 14 and corresponding contacts 42 on the base unit 12 form switches. When the contacts 40, 42 are engaged (as they would be in standard mode use), communication between the base unit 12 and the handset 14 occurs through direct transmission of electric signals via the 5 contacts 40, 42 (as will be described in detail further below with respect to FIGURES 6 and 7). Thus, in the standard mode, the user holds the phone 10 and uses it in substantially the same manner as any conventional cellular phone.

To use the phone 10 in the reduced exposure mode, the user 10 detaches the handset 14 from the base unit 12. As shown in FIGURE 5, the base unit 12 is placed a distance away from the user to reduce his or her exposure to RF radiation emitted by the antenna 20. The user communicates through the handset 14 as he would with any standard telephone handset. A digital IR communications link is established to 15 transmit signals between the handset 14 and the base unit 12 in the reduced exposure mode. When the user detaches the handset 14 from the base unit 12, the contacts 40, 42 are disengaged, and communications between handset 14 and base unit 12 is switched to the digital IR communications link. The link is established between the IR 20 send/receive unit 38 on the handset 14 and the corresponding IR send/receive unit 36 on the base unit 12.

The handset infrared unit 38 comprises a pseudo-omnidirectional send and receive unit 44 positioned at the end of a telescopic device 46. This telescopic device 46 is preferably located on the mouthpiece member 25 24 of the handset 14. Its location in the mouthpiece member 24 offers a greater chance of an unhindered line-of-sight communication link between the handset 14 and the base unit 12. It should be noted, however, that the infrared unit 38 can also instead be positioned on the earpiece member 22 of the handset 14 as indicated in phantom at 48 in FIGURE 5.

30 In the reduced exposure mode, the base unit 12 of the phone 10 is separated from the user a distance sufficient to significantly reduce

harmful exposure to RF radiation. Radiation strength is inversely proportional to the square of the distance to the source (at least in first order approximation). Therefore, to reduce the radiation level by a factor of 1000 (meaning the exposure would be 0.1% of the original or that 5 radiation would be reduced by 99.9%), the source would have to be moved a distance by a factor of about 32. Since most cellular phones are designed to have their antennas close (about 1 inch) to the user's head, reduction by 99.9% would require a separation distance of about 3 feet.

Unlike RF emissions, the infrared radiation emitted by the IR 10 send/receive units 36, 38 on the handset 14 and the base unit 12 is not known to pose any health hazard.

The phone 10 is battery powered. As shown in FIGURES 2 and 4, the base unit 12 includes a rechargeable battery 49, and the handset 14 includes a rechargeable battery 51. The base unit 12 and the handset 14 15 also include contacts 53, 55 connected to their respective batteries 49, 51. When the handset 14 and the base unit 12 are attached, the contacts 53, 55 are engaged, permitting both batteries 49, 51 to be simultaneously charged.

FIGURE 6 illustrates in general the functional blocks of a prior art 20 digital cellular phone 100 as specified by the CTIA IS-54 standard. The schematic diagram (from Digital Cellular Phone: A functional analysis by Raj Pawate and Mansoor Chishtie) provides background information for further understanding of the present invention. In brief, a human voice input to a mouthpiece is converted to an analog electric signal by a microphone 102. The signal is fed through an amplifier 104, after which 25 it is converted to a digital bit stream in an analog to digital converter 106. This bit stream is then fed through a speech encoder 108 and a channel encoder 110. It is then modulated at 112 and filtered for RF transmission from an antenna 114. Similarly, RF signals received from the antenna 30 114 are filtered, demodulated at 116, decoded by a channel decoder 118 and by a speech decoder 120, converted to an analog signal in a digital to

analog converter 122, amplified at 124 and output as an audio signal from a speaker 126.

FIGURE 7 schematically illustrates the infrared communications link of the present invention. The phone 10 of the present invention generally includes the functional components of the digital cellular phone 100 of FIGURE 6. In addition, the phone 10 includes the components for establishing the IR communications link and switches for switching between the IR communications link (when the phone 10 is used in the reduced exposure mode) and the direct electric contact link (when the phone 10 is used in the standard mode).

As shown in FIGURE 7, additional switches 50 and IR send and IR receive units 52, 54 are located between a speech coder 56 and a channel coder 58 in the input path from the mouthpiece 30. Also, additional switches 60 and IR send and IR receive units 62, 64 are located between the speech decoder 66 and channel decoder 68 in the output path to the earpiece 28. The IR send unit 52 and the IR receive unit 64 form the send/receive unit 38 on the handset 14. Similarly, the IR send unit 62 and the IR receive unit 54 form the send/receive unit 36 on the base unit 12.

The switches 50, 60 are connected to the electric contacts 40, 42 on the base unit 12 and the handset 14, and are designed to switch to the IR communications link when the contacts 40, 42 are disengaged. When the handset 14 is attached to the base unit 12, the contacts 40, 42 are engaged, and communication between the handset 14 and the base unit 12 is switched to direct electrical contact through wires 70. The switches 50, 60 are linked as indicated symbolically by dash line 72 to operate in concert, i.e., they switch between communication links simultaneously.

In the reduced exposure mode, a human voice input to the mouthpiece 30 of the handset 14 is converted to an analog electric signal by the microphone 32. The signal is fed through an amplifier 74, after

which it is converted to a digital bit stream in an analog to digital converter 76. This bit stream is then fed through the speech encoder 56 and thereafter converted to and transmitted as an IR signal by the IR send unit 52. The signal is then remotely received by the IR receive unit 54 of 5 the base unit 12. It is converted to an electric signal and fed to the channel encoder 58. It is then modulated and filtered for RF transmission through the antenna 20 (not shown in FIGURE 7). Similarly, RF signals received from the antenna 20 of the base unit 12 are filtered, demodulated, and then decoded by the channel decoder 68. The signal is 10 then transmitted optically by the IR send unit 62. It is received remotely by the IR receive unit 64 on the handset 14 and fed through the speech decoder 66, converted to an analog signal in the digital to analog converter 78, amplified at 80 and output as an audio signal from the speaker 34.

15 In this manner, the user is isolated from harmful radiation exposure to all portions of his or her body. Thus, the phone 10 enables reduced radiation exposure, yet is fully portable and wireless. It is also easy to use and provides good sound quality

It should be appreciated by those skilled in the art that the specific 20 embodiments disclosed above may be readily utilized as a basis for modifying or designing other devices for carrying out the purposes of the present invention. It should also be realized by those skilled in the art that such equivalent constructions do not depart from the spirit and scope of the invention as set forth in the appended claims.

**IN THE CLAIMS**

1. A telephone for use in a wireless communications network for isolating a user from telephone radio frequency ("RF") emissions, comprising:

5 a base unit including:

an RF transmitter for transmitting output RF signals to said network; and

an RF receiver for receiving input RF signals from said network;

10 a user interface unit including:

a mouthpiece for receiving input audio signals from the user; and

an earpiece for transmitting output audio signals to the user; and

15 an optical communications link for enabling remote optical communication between said base unit and said user interface unit.

2. The telephone of claim 1,

20 wherein said base unit further includes circuitry for converting the input RF signals into input electrical signals and for converting output electric signals from said user interface unit into said output RF signals;

25 wherein said user interface unit further includes circuitry for converting the input audio signals to said output electric signals and for converting input electric signals from said base unit to said output audio signals; and

30 wherein said optical communications link includes a first element associated with said base unit for optically transmitting said input electric signals from said base unit to said interface unit, and a second element associated with

said user interface unit for optically transmitting said output electric signals from said interface unit to said base unit.

3. The telephone of Claim 1, wherein said user interface unit is  
5 detachably connected to said base unit.

4. The telephone of Claim 3, further including a switch responsive to detachment of said user interface unit from said base unit for activating said optical communications link.

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5. The telephone of Claim 4, wherein said switch comprises first contacts on said user interface unit and second contacts on said base unit, wherein said first and second contacts are engaged when said user interface unit is attached to said base unit to establish a direct link for  
15 transmitting said output electric signals from said interface unit to said base unit, and said input electric signals from said base unit to said interface unit.

6. The telephone of Claim 3, wherein said user interface unit  
20 and said base unit include rechargeable batteries that can be simultaneously charged when said user interface unit and said base unit are connected.

7. The telephone of Claim 2, wherein said first and second  
25 elements of said optical communications link each comprise an infrared send/receive unit for transmitting and receiving infrared optical signals.

8. The telephone of Claim 2, wherein said circuitry in said  
interface unit for converting input audio signals to output electric signals  
30 includes a microphone.

9. The telephone of Claim 2, wherein said circuitry in said interface for converting input electric signals to said output audio signals includes a speaker.

5 10. The telephone of Claim 2, wherein said circuitry in said base unit for converting input RF signals into input electrical signals includes a demodulator.

10 11. The telephone of Claim 2, wherein said circuitry in said base unit for converting output electric signals to output RF signals includes a modulator.

12. The telephone of Claim 1, wherein said user interface unit comprises a handset.

15 13. The telephone of Claim 12, wherein said handset comprises a first member including said mouthpiece and a second member including said earpiece, and said first and second members are pivotally connected to enable compact folding of said handset.

20 14. A telephone for use in a wireless communications network for isolating a user from telephone radio frequency ("RF") emissions, comprising:

a base unit including:

25 an RF transmitter for transmitting output RF signals to said network; and  
an RF receiver for receiving input RF signals from said network;

30 a user interface unit detachably connected to said base unit such that said user interface unit can be detached from said base unit for use of the phone in a reduced emissions mode, and the user interface unit can

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be attached to the phone and operable therewith for use of the phone in a standard use mode, said user interface unit including:

a mouthpiece for receiving input audio signals from the user; and

5 an earpiece for transmitting output audio signals to the user; and

an optical communications link for enabling remote optical communication between said base unit and said user interface unit in the reduced emissions mode.

10

15. The telephone of claim 14,

wherein said base unit further includes circuitry for converting the input RF signals into input electrical signals and for converting output electric signals from said user interface unit into said output RF signals;

15 wherein said user interface unit further includes circuitry for converting the input audio signals to said output electric signals and for converting input electric signals from said base unit to said output audio signals; and

20 wherein said optical communications link includes a first element associated with said base unit for optically transmitting said input electric signals from said base unit to said interface unit, and a second element associated with said user interface unit for optically transmitting said output electric signals from said interface unit to said base unit.

25

16. The telephone of Claim 14, further including a switch responsive to detachment of said user interface unit from said base unit for activating said optical communications link.

30

17. The telephone of Claim 16, wherein said switch comprises first contacts on said user interface unit and second contacts on said base unit, wherein said first and second contacts are engaged when said user interface unit is attached to said base unit to establish a direct link for 5 transmitting said output electric signals from said interface unit to said base unit, and said input electric signals from said base unit to said interface unit.

18. The telephone of Claim 15, wherein said first and second 10 elements of said optical communications link each comprise an infrared send/receive unit for transmitting and receiving infrared optical signals.

19. The telephone of Claim 15, wherein said circuitry in said interface unit for converting input audio signals to output electric signals 15 includes a microphone.

20. The telephone of Claim 15, wherein said circuitry in said interface for converting input electric signals to said output audio signals includes a speaker.

21. The telephone of Claim 15, wherein said circuitry in said base unit for converting input RF signals into input electrical signals includes a demodulator.

25 22. The telephone of Claim 15, wherein said circuitry in said base unit for converting output electric signals to output RF signals includes a modulator.

30 23. The telephone of Claim 14, wherein said user interface unit comprises a handset.

15

24. The telephone of Claim 23, wherein said handset comprises a first member including said mouthpiece and a second member including said earpiece, and said first and second members are pivotally connected to enable compact folding of said handset.

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25. The telephone of Claim 14, wherein said user interface unit and said base unit include rechargeable batteries that can be simultaneously charged when said user interface unit and said base unit are connected.

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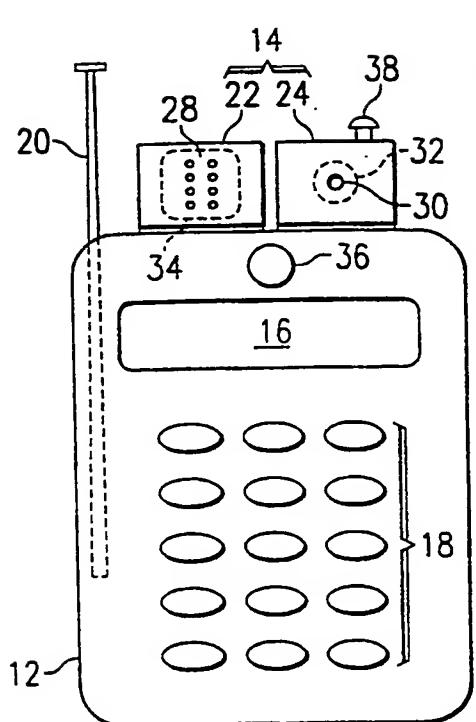


FIG. 1

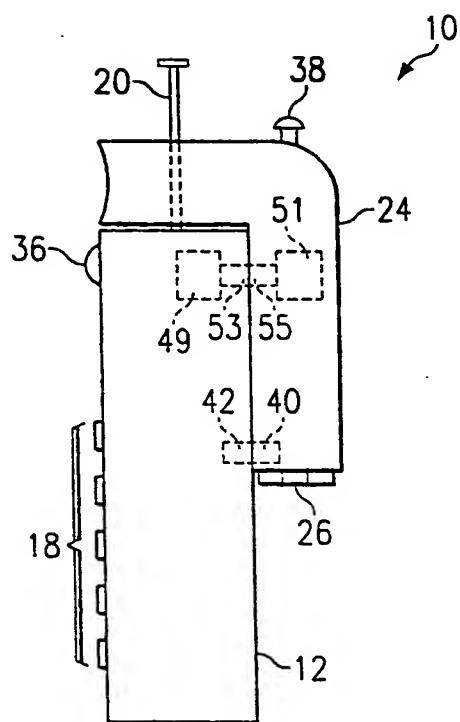


FIG. 2

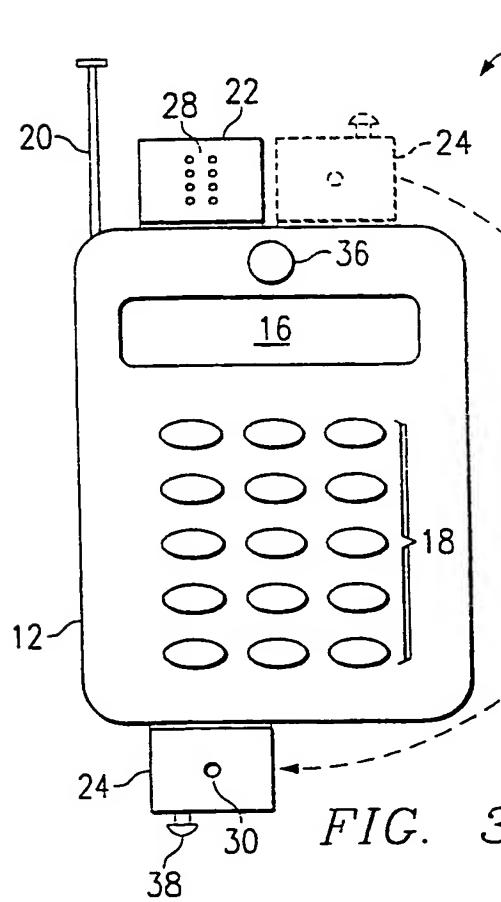


FIG. 3

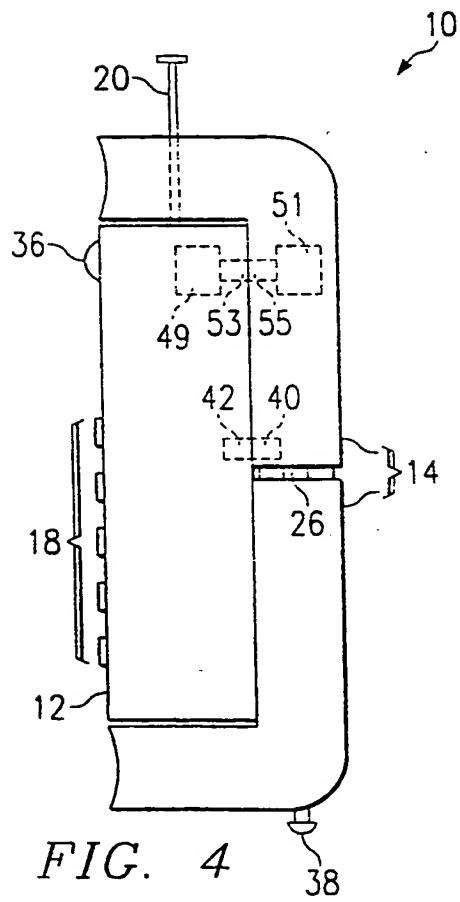
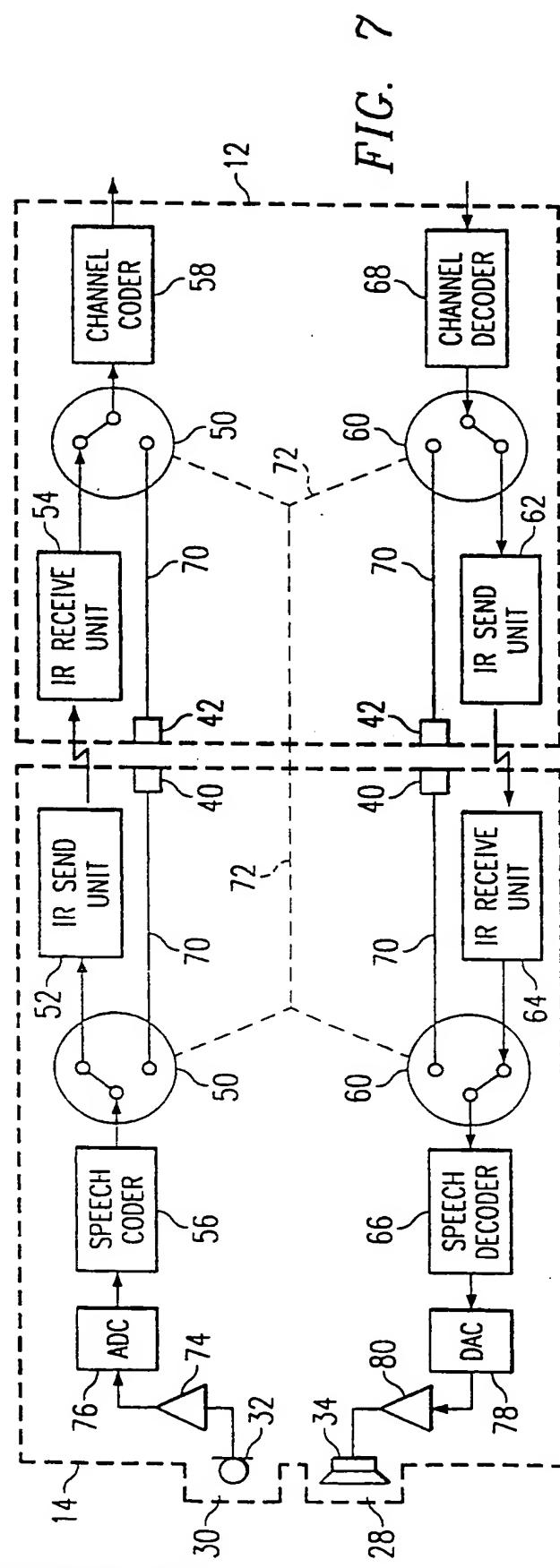
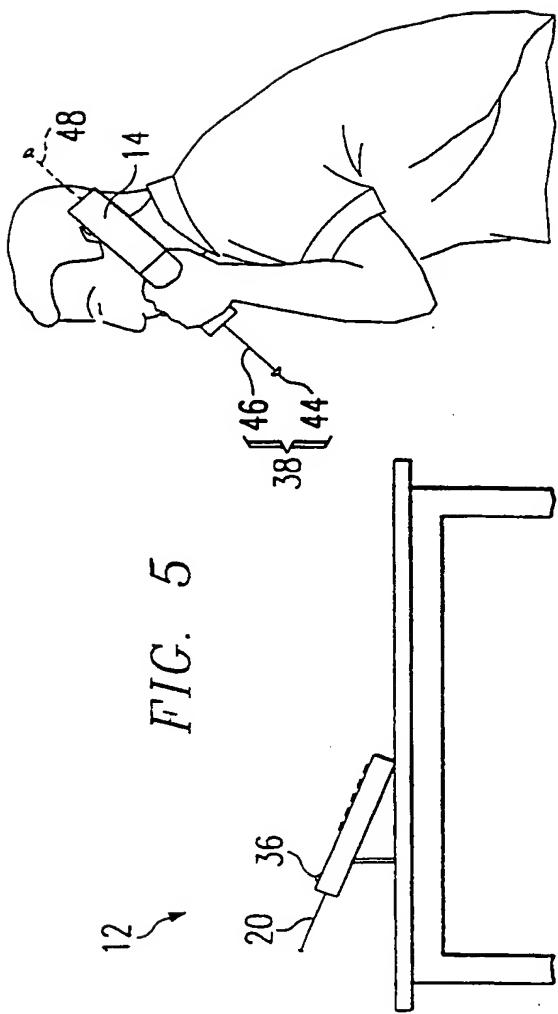
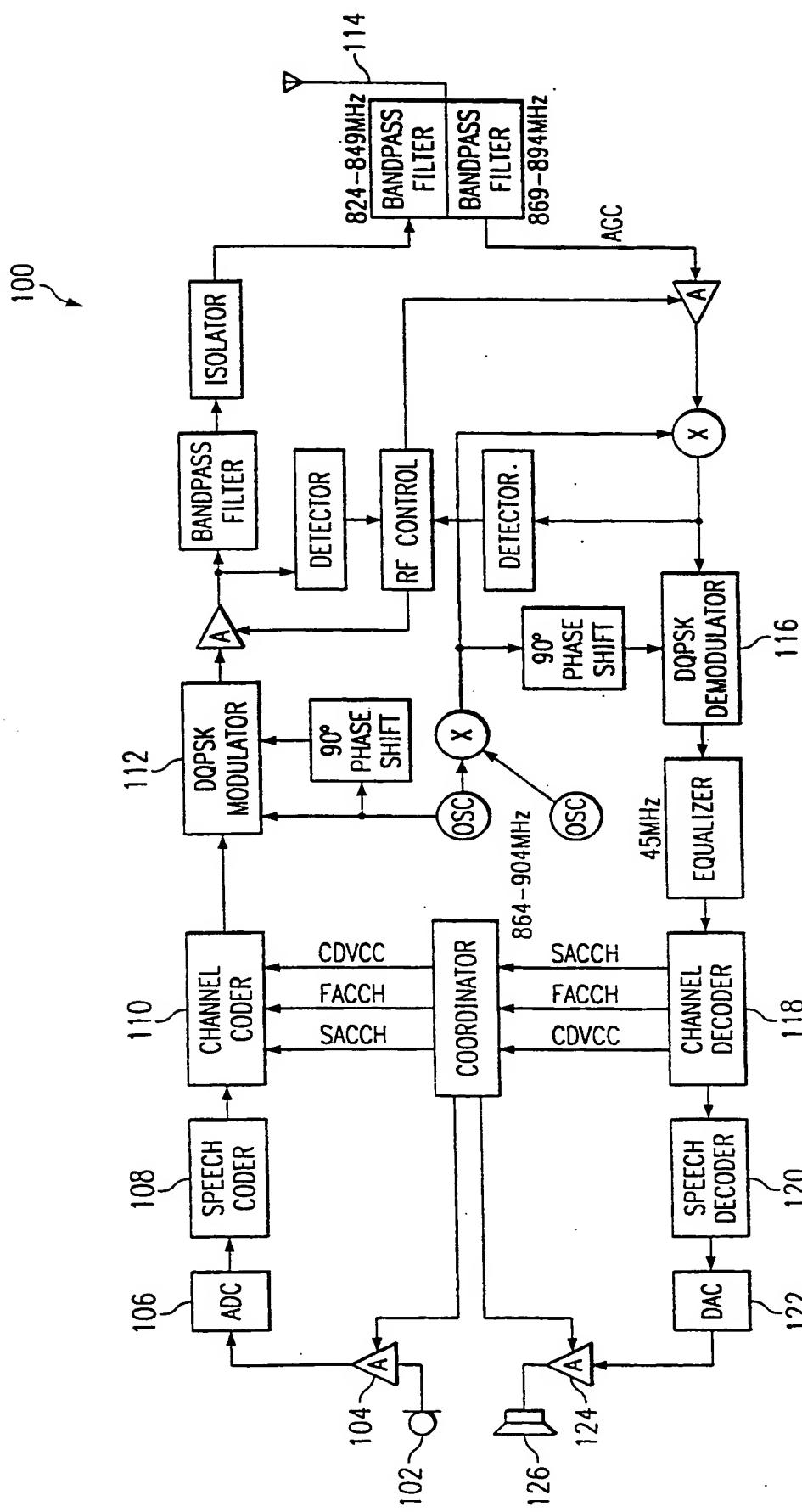


FIG. 4





*FIG. 6  
(PRIOR ART)*

CDVCC = coded digital verification color code  
DQPSK = differential quaternary phase-shift keying  
FACCH = fast associated control channel  
SACCH = slow associated control channel

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US99/05531

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) : F04M 11/00

US CL : 455/117

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 455/117, 550, 575, 90, 128, 129, 346, 97, 66; 379/420, 433, 428, 56.2, 56.3

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched  
none

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)  
WEST search terms: radiation, infrared, optical, telephone, phone

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4,456,793 A (BAKER ET AL.) 26 JUNE 1984, ABSTRACT AND FIGURE 6	1-25
Y	US 4,775,996 A (EMERSON ET AL.) 04 OCTOBER 1988, ABSTRACT, FIGS. 1 AND 2	1-25
Y	US 4,776,000 A (PARENTI) 04 OCTOBER 1988, ABSTRACT AND FIGURES 1, 3 AND 5	1-25
Y	US 4,882,745 A (SILVER) 21 NOVEMBER 1989, ABSTRACT, FIG. 3, COLUMN 2, LINES 45-53	1-25

Further documents are listed in the continuation of Box C.  See patent family annex.

* Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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Date of the actual completion of the international search	Date of mailing of the international search report
07 JUNE 1999	15 JUN 1999
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